UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/694,172	10/28/2003	Kazuyoshi Ueno	Q78176	2754

23373 7590 11/07/2008

SUGHRUE MION, PLLC
2100 PENNSYLVANIA AVENUE, N.W.
SUITE 800
WASHINGTON, DC 20037

EXAMINER	
LIGHTFOOT, ELENA TSOY	
ART UNIT	**PAPER NUMBER**
1792	

MAIL DATE	DELIVERY MODE
11/07/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/694,172	UENO ET AL.	
	Examiner	Art Unit	
	Elena Tsoy Lightfoot	1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *26 September 2008* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-5,7 and 9-20* is/are pending in the application.

4a) Of the above claim(s) *1-5 and 12-17* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *7,9-11 and 18-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on September 26, 2008 has been entered.

Response to Amendment

Amendment filed on September 26, 2008 has been entered. Claims 1-5, 7 and 9-20 are pending in the application. Claims 1-5 and 12-17 are withdrawn from consideration as directed to a non-elected invention.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 7, 9 and 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al (US 6180523) in view of Sambucetti et al (US 6335104), further in view of Whitlow et al (US 5330088), Aisaka et al (JP 04297001) and Semkow et al (US 6,060,176).

Lee et al disclose Ultra-Large Scale Integrated (ULSI) wiring (See Abstract) comprising a first insulating interlayer 20 having at least one of trench and via formed in the first insulating layer 20 of e.g. silicon dioxide (See column 12, lines 17-18), a first barrier layer 34 (claimed

diffusion prevention layer) on the adhesion layer 28 formed on side walls of the at least one of trench and via and on a bottom of a substrate 10 of silicon dioxide (See column 2, lines 59-60), a wiring layer 38 formed in the space of the first barrier layer 34, and a second insulating layer 42 covered over at least the wiring layer, wherein the first barrier layer 34 is made of a *plating* film selected from the group consisting of Ni, Pd, Co or alloys of Ni, Pd, Co, but not limited to these (See Fig. 6; column 8, lines 50-59; column 10, lines 20-23). Lee et al teach that the *adhesion* layer is preferably composed of Al or Al alloys, polysilicon, Ni, titanium or amorphous silicon (See column 8, lines 15-17). Lee et al teaches that a first barrier layer 34 (claimed diffusion prevention layer) on an adhesion layer 28 (See column 5, lines 60-61), wherein the adhesion layer 28 is ***preferably*** composed of polysilicon or amorphous silicon (See column 8, lines 15-17) formed by **LPCVD** (See column 8, line 26). It is well known in the art that polysilicon is deposited with LPCVD using **silane *decomposition***. Therefore, the first barrier layer 34 (claimed diffusion prevention layer) would contain Si because it would further diffuse into the diffusion prevention layer under the heat of LPCVD and/or under heating treatments that are always included in ULSI wiring manufacturing process.

Lee et al further teaches that the first barrier layer 34, diffusion prevention layer for the **metal layer of e.g. Cu** or Au (See Fig. 9; column 6, lines 1-2) is preferably composed of electroless plated layer of Ni, Pd, Co or alloys thereof, but not *limited* to these (See column 8, lines 49-56). Lee et al does not expressly teach that the first barrier layer 34 (claimed diffusion prevention layer) may also be made of nickel-boron. However, Lee et al teaches that a second barrier layer 46 may be formed on the wiring layer 38 by electroless *plating*, wherein the second barrier layer 46 is made of a nickel-boron, Pd or Co or Cu, Au, most preferably of Ni-B to reduce

the resistivity (See Fig. 8; column 10, lines 36-37) for *copper migration* (See column 4, lines 19-20). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have made the first barrier layer 34 of nickel-boron instead of Pd or Co with the expectation of providing the desired reduced resistivity for *copper migration*.

Lee et al fails to teach that the first barrier layer 34 comprises a plating film selected from the group consisting of Ni-W-P and Ni-Rh-P (Claim 7).

Sambucetti et al teaches that a diffusion barrier layer 16 of a metal alloy material such as a phosphorus or boron-containing alloy of Ni-P, Co-W-P, Co-Sn-P, **Ni-W-P**, Co-B, Ni-B, Co-Sn-B, Co-W-B and Ni-W-B is suitable for prevention of copper diffusion (See FIG. 1; column 5, line 61 to column 6, line 18).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used Ni--W--P as a diffusion prevention film in Lee et al with the expectation of providing the desired prevention of the first Cu layer from diffusing since Sambucetti et al teaches that an electroless Ni-B film or Ni--W--P film is suitable for preventing Cu from diffusion, and Lee et al do not limit their teaching to particular Ni alloys.

Lee et al in view of Sambucetti et al fails to teach that the first barrier layer 34 comprises a plating film of Ni-Re-P.

Whitlow et al teaches that a deleterious *diffusion of copper* into a contact can be prevented by placing an impermeable barrier layer between the braze material and the contact. The material for this barrier may be any element or alloy which does not alloy with the species that is being prevented from diffusing into the contact material such as *tungsten* and *rhenium* with which copper does not alloy or exhibit any solid solubility. See column 1, lines 51-65.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used rhenium to alloy with nickel in Lee et al in view of Sambucetti et al instead of tungsten with and phosphorus with the expectation of providing the desired copper diffusion barrier since Whitlow et al teaches that either *tungsten* or *rhenium* may be used for forming copper diffusion barrier.

One of ordinary skill in the art would have reasonable expectation of success in making Ni-Re-P film since Ni-Re-P alloy film is well known in the art and used for forming e.g. a resistor, as evidenced by Aisaka et al (See Abstract), or for forming a corrosion protection layer, as evidenced by Semkow et al (See column 5, lines 10-13, 22). It is also well known in the art that Ni-Re-P film may be deposited by electroless **plating**, as evidenced by Aisaka et al (See Abstract).

As to claimed thickness, Sambucetti et al teach that a suitable thickness for the first diffusion barrier layer 16 may be within a range of 1,000-10,000 ANG. (100-1,000 nm) (See column 6, lines 2-7), e.g. **100 nm** (See Example A) (See column 6, lines 29-30).

Moreover, the Examiner takes official notice that it is a common knowledge in the art that effect of protection layer depends on the thickenss of the layer. It is held that it is not inventive to discover the optimum or workable ranges of result-effective variables by routine experimentation. In re Antonie, 559 F.2d 618, 195 USPQ 6 (CCPA 1977). See also In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have determined the optimum values of the relevant thickness parameters (including those of claimed invention) in the cited prior art through routine experimentation in the absence of showing of criticality.

As to claim 18, Aisaka et al teaches that **Ni-Re-P** alloy thin-film having 5-75wt % rhenium content and 1-14% phosphorus content formed onto a base material through an electroless plating method may be used for forming a resistor since it has high specific resistance value and temperature resistance coefficient (See Abstract). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used **Ni-Re-P** alloy for forming a copper diffusion barrier film in the cited prior art with the expectation of providing the desired high specific resistance value and temperature resistance coefficient, as taught by Aisaka et al.

Note that alloy ranges of Aisaka et al overlap claimed ranges. It is well settled that overlapping ranges are prima facie evidence of obviousness. It would have been obvious to one having ordinary skill in the art to have selected the portion of Aisaka et al's range that corresponds to the claimed range.

Moreover, it is held that concentration limitations are obvious absent a showing of criticality. Akzo v. E.I. du Pont de Nemours 1 USPQ 2d 1704 (Fed. Cir. 1987). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have determined the optimum values of the relevant concentration parameters (including those of claimed invention) in the cited prior art through routine experimentation depending on particular coating composition in the absence of a showing of criticality.

As to Amendment of claim 7, Lee et al teaches that their invention discloses a technique of utilizing electroless deposition in USLI circuits. This metalization process is an additive and selective to provide **conducting layers** as well as an interconnection between layers of a

multilevel conductive metal semiconductor device. See column 10, lines 60-62; Abstract; column 5, lines 41-45; column 2, lines 9-12.

As to claim 20, Lee et al teaches that the invention provides three embodiments for forming **Cu**/Au contacts and interconnects using electroless deposition (See Abstract).

3. Claims 9-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al in view of Sambucetti et al, further in view of Whitlow et al, Aisaka et al and Semkow et al, as applied above, and further in view of Neary (US 4424805) and Vullaume et al (Applied Physics Letters, vol. 69, pages 1646-1648, 1996) described by Wada et al (US 20050056828)*.

*The Examiner Note: the Examiner will refer to Wada et al (US 20050056828) for description of Vullaume et al.

The cited prior art is applied here for the same reasons as above. Lee et al fails to teach that an adhesion layer between said first insulating layer and said diffusion prevention layer contains at least one of silicon and carbon (Claims 7); the adhesion layer is substantially made of silane compound layer (Claim 10) such as a monomolecular layer of a silane compound layer containing an amino group (Claim 11).

Neary teaches that organo silicon monomers which characteristically possess two or more different types of chemical functionality can be used for bonding *dissimilar* materials (See column 5, lines 50-55). For example, silanes may be used for bonding silicon oxide surface by reacting silanol moiety with the surface oxide thus leaving organic functional group, R, extended away from the surface (See column 6, lines 6-19). When R is **amino** group, silane can be bonded to metal surfaces by complexation, coordination or chelation (See column 6, lines 25-30).

Therefore, it would be obvious to one of ordinary skill in the art to use amino group containing silane to bond silicon oxide with metal.

Vullaume et al teach that a monomolecular layer of a silane coupling agent functions as a gate insulating film (for example, makes the leakage current satisfactorily small): the leakage current in the monomolecular layer of the silane coupling agent is smaller by 4 to 5 digits than that in silicon oxide having the same thickness (See US 20050056828 to Wada et al, P205).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used a monomolecular layer of amino group containing silane coupling agent in Lee et al instead of adhesive with the expectation of providing the desired bonding of silicon oxide with metal and the desired satisfactorily small leakage current, as taught by Neary and Vullaume et al.

Response to Arguments

4. Applicant's arguments with respect to claims 7, 9 and 18-20 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Elena Tsoy Lightfoot whose telephone number is 571-272-1429. The examiner can normally be reached on Monday-Friday, 9:00AM - 5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks can be reached on 571-272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications

may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Elena Tsoy Lightfoot, Ph.D.
Primary Examiner
Art Unit 1792

November 7, 2008

/Elena Tsoy Lightfoot/